



LANDSAT DATA CONTINUITY MISSION

OPERATIONAL LAND IMAGER

STATEMENT OF WORK

Revision C

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**National Aeronautics and
Space Administration**

**Goddard Space Flight Center
Greenbelt, Maryland**

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CM FOREWORD

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Questions or comments concerning this document should be addressed to:

LDCM Configuration Management Office
Mail Stop 427
Goddard Space Flight Center
Greenbelt, Maryland 20771

Signature Page**Prepared by:*****Concurrence on File*** 01/18/13_____
Jeanine E. Murphy-Morris
LDCM OLI Instrument Manager
NASA/GSFC – Code 427_____
Date**Reviewed by:*****Concurrence on File*** 01/18/13 ***Concurrence on File*** 01/19/13_____
Jeanine E. Murphy-Morris
LDCM Observatory Manager
NASA/GSFC – Code 427_____
Date_____
Dann Brown
LDCM Chief Safety and Mission
Assurance Officer (CSO)
NASA/GSFC – Code 323_____
Date***Concurrence on File*** 01/21/13 ***Concurrence on File (J. Nelson for)*** 01/21/13_____
Evan H. Webb
LDCM Mission Systems Manager
NASA/GSFC – Code 599_____
Date_____
Dave Hair
USGS LDCM Project Manager
USGS/EROS_____
Date***Concurrence on File*** 01/22/13_____
Del T. Jenstrom
LDCM Deputy Project Manager
NASA/GSFC – Code 427_____
Date**Approved by:*****Signature on File (D. Jenstrom for)*** 01/30/13_____
Ken Schwer
LDCM Project Manager
NASA/GSFC – Code 427_____
Date

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I. Introduction

The Landsat Data Continuity Mission (LDCM) is the successor mission to Landsat 7. Landsat satellites have continuously acquired multi-spectral images of the global land surface since the launch of Landsat 1 in 1972. The Landsat data archive constitutes the longest record of the land surface as viewed from space. The LDCM mission objective is to extend the ability to detect and quantitatively characterize changes on the global land surface at a scale where natural and man-made causes of change can be detected and differentiated. The Operational Land Imager (OLI) is the reflective-band science data-producing sensor for the LDCM.

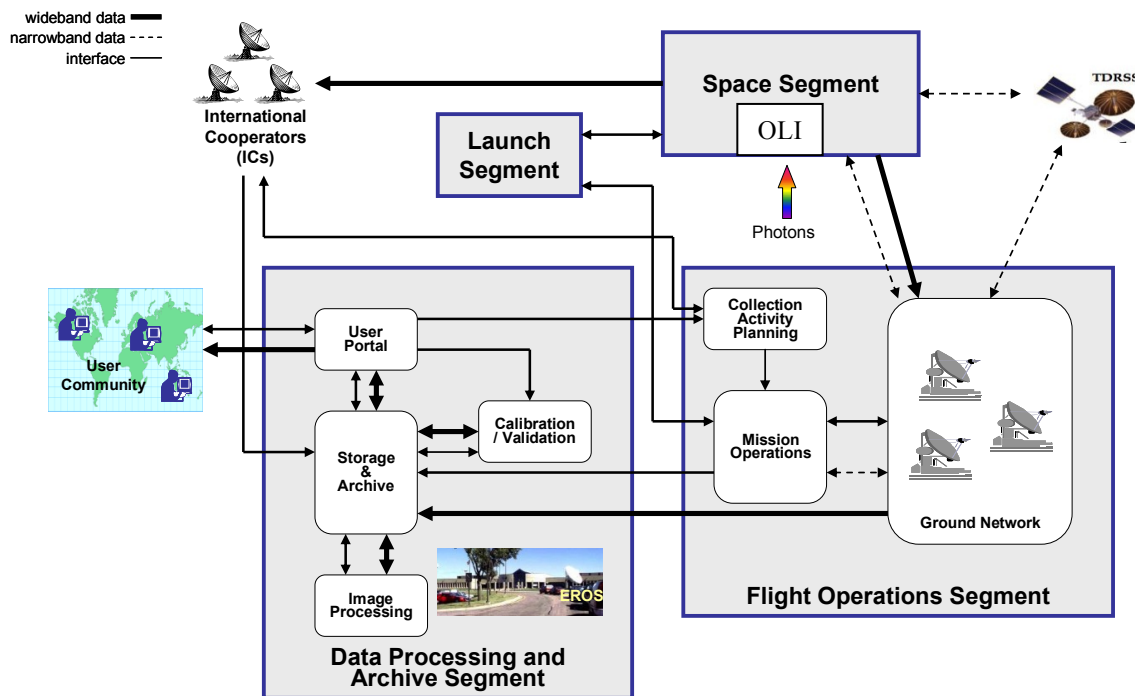
II. Scope

This Statement of Work (SOW) defines the minimum effort required of the Contractor that shall include but is not limited to the design, engineering analyses, development, fabrication, integration, algorithm development, test, evaluation, delivery, and support for the Operational Land Imager (OLI) instrument, a portion of the Landsat Data Continuity Mission. The Government is responsible for integration of the LDCM. Figure 1 is a block diagram of the LDCM segments and elements, and their interfaces for reference. The Contractor provides support for the OLI-related portions of the Government's mission system integration effort.

This Statement of Work requires delivery of all contract deliverables associated with the OLI development. The OLI shall meet the requirements of all contractual documents.

The interface design of the OLI to the spacecraft will be refined after OLI contract award through trade study interaction with potential spacecraft bus contractors, and through OLI contractor and Government participation in development of the OLI interface requirements for the spacecraft bus procurement. After a spacecraft bus contractor is selected, the spacecraft contractor will assume primary responsibility for leading development of the OLI-to-spacecraft interface control documentation in coordination with the OLI contractor.

FIGURE 1
LDCM SEGMENTS, ELEMENTS, AND INTERFACES



III. Definitions

The following definitions apply to this document:

Operational Land Imager (OLI) – The term OLI refers to the multi-band sensor and associated electronics, software, and harnessing that meets the performance requirements in the OLI-RD and Observatory IRD.

Contractor – The developer of the item of reference. If the term contractor is used in this document without specific reference to an item (e.g., OLI, spacecraft bus, TIRS, etc.), then the term shall be interpreted to imply the OLI contractor. In all cases, the term contractor also implies any and all associated suppliers and subcontractors.

Shall – Compliance by the Contractor is mandatory. Any deviations from these contractually imposed mandatory requirements require the approval of the contracting officer.

May – At the discretion of the Contractor or Government.

Will – Designates the intent of the Government. Unless required by other contract provisions, noncompliance with the *will* requirements does not require approval of the contracting officer and does not require documented technical substantiation.

Engineering Peer Review (EPR) – a meeting between approximately 2 to 5 Government representatives and Contractor technical representatives to provide focused, in-depth technical reviews that support the evolving design and development of a product subsystem or engineering discipline area, such as the thermal system. The purpose of an EPR is to reduce risk through expert knowledge infusion, confirmation of approach, and specific recommendations. An EPR provides an examination of design, analysis, manufacturing, integration, test and operational details, drawings, processes and data.

Technical Interchange Meeting (TIM) – an informal meeting, between the Contractor and approximately 5 to 10 Government representatives, and/or the spacecraft and MOE contractor personnel to discuss a system process or feature. For example, to reach understanding of an operation or analysis, presentation of test results, discuss planned interface changes, plan for an upcoming test, etc. TIMs typically are held at the contractor's facility and typically run no more than two days. TIMs involving the OLI contractor may also be conducted at the spacecraft or MOE contractors' facilities. Actions are informally tracked by the TIM organizer.

Major Review – Major reviews are major milestones in the implementation where information is formally presented to a panel of Government experts and external reviewers. DRs can involve up to approximately 30 Government representatives and typically run up to four days. Formal action items are logged and tracked by the Project Office.

IV. Applicable Documents

The documents listed in this section apply directly to the performance of the OLI Contract. These documents establish detailed specifications, requirements, and interface information necessary for the performance of the contract. In case of conflicting requirements, the order of precedence of documents not specifically called out in the Contract is: this Statement of Work, the Instrument Mission Assurance Requirements document, the OLI Requirements Document, the Observatory Interface Requirements Document, the Contract Data Requirements List, the LDCM Environmental Verification Requirements, and the OLI Special Calibration and Test Requirements. In the event of

conflict between the Observatory Interface Requirements Document and the Interface Control Documents (ICDs), the ICDs take precedence.

- Operational Land Imager Requirements Document: Document Number GSFC 427-05-03
- Special Calibration Test Requirements: Document Number GSFC 427-05-04
- Operational Land Imager Contract Data Requirements List: Document Number GSFC 427-05-02
- LDCM Observatory Interface Requirements Document : Document Number GSFC 427-02-03
- Instrument Mission Assurance Requirements: Document Number GSFC 427-03-03
- LDCM Environmental Verification Requirements: Document Number GSFC 427-03-05
- LDCM Acronym List and Lexicon: Document Number GSFC 427-02-06
- Top of Atmosphere Radiance Values, MODTRAN 4 Model. Document Number GSFC 427-04-01
- NIST 2000 realization of scale of spectral irradiance, H. W. Yoon, C. E. Gibson and P. Y. Barnes, The realization of the NIST detector-based spectral irradiance scale, Metrologia 40 (2003) S172–S176.
- Landsat Worldwide Reference System-2 (WRS-2) Definition, February 9, 2006: Document Number GSFC 427-02-07
- Criteria for Flight Project Critical Milestone Reviews, GSFC-STD-1001, February 2005
- NPR 2810.1, Security of Information Technology
- NASA Policy Directive 8010.2, Use of the SI (Metric) System of Measurement in NASA Programs
- GPR 1060.2, Management Review and Reporting for Programs and Projects
- GPR 8700.4, Integrated Independent Reviews
- NPR 5100.4, Federal Acquisition Regulation Supplement
- NPR 8000.4, Risk Management Procedural Requirements
- NPR 8715.3, NASA Safety Manual
- GPR 7120.4, Risk Management

- Landsat Data Continuity Mission Spacecraft to Operational Land Imager (OLI) Interface Control Document (ICD), General Dynamics Advanced Information Systems Document 70-P58204P

- Landsat Data Continuity Mission (LDCM) 1553 Interface Control Document (ICD), General Dynamics Advanced Information Systems Document 70- P58206P

Reference Documents

- LDCM Operations Concept: Document Number GSFC 427-02-02

- NASA NPR 7120.5D NASA Program and Project Management Processes and Requirements

V. Work to be Performed

This section, along with the Contract Data Requirements List (CDRL) document GSFC 427-05-02, describes the specific work to be accomplished by the OLI instrument Contractor. In accordance with the requirements of this document, the contract, all associated requirements documents, and the other attachments and applicable documents to this contract, the Contractor shall provide the effort and resources that include, but are not limited to, personnel, materials, equipment, and facilities necessary for the successful and on-time implementation of the design, analysis, development, fabrication, assembly, integration, test, engineering data analyses, calibration, qualification, and delivery of the OLI. The Contractor shall also provide the personnel, materials, equipment, and facilities necessary for support to Observatory Integration and Test, support to mission level activities, and sustaining engineering of the OLI.

The Contractor shall deliver to the Government an OLI that is fully tested, calibrated, and has demonstrated compliant and reliable operation in accordance with the requirements of this contract.

1 Management

1.1 Project Management

The Contractor shall maintain a project office to manage the technical activities and resources of the OLI project. The Contractor shall appoint a dedicated Project Manager to direct and manage the OLI project. The Contractor's Project Manager shall have responsibility for the overall technical performance, resource management, and schedule management of the contractual effort and all subcontracts. The Contractor's designated Project Manager shall report to a level of company management appropriate to ensure prompt resolution of all problems. For costing purposes, the duration of Project Management shall be until on-orbit acceptance. Project Management activities after final on-orbit acceptance of OLI shall be as specified within section 6.0.

The Contractor shall prepare a Project Management Plan, an Organizational Conflict of Interest Plan, and a Final Report in accordance with CDRL PM-11, CDRL PM-13, and CDRL PM-4, respectively.

1.1.1 Government Oversight

The Contractor shall open to Government attendance all Contractor and subcontractor internal data, reviews, audits, meetings and other activities within the scope of the contract. For access and insight activity, "Government" includes Government personnel and Government contractor personnel. The Contractor shall allow and enable the use of

Non-Disclosure Agreements with Government contractors where appropriate. The Contractor shall notify the Contracting Officer, the Government Resident Office and the Contracting Officer's Technical Representative (COTR) of meetings, reviews or tests in sufficient time (nominally 10 working days) to permit meaningful Government participation.

1.2 Reviews and Meetings

The reviews listed in this section should not be considered a comprehensive set of reviews for the Contractor's program. Additional reviews that the Contractor deems necessary to successfully execute the program may be conducted at the Contractor's discretion. The Contractor shall notify the Government at least 10 working days in advance of lower level Contractor subsystem reviews to allow the Government time to attend the review as part of its insight activities.

1.2.1 Major Reviews

All major reviews will be convened and review boards appointed and chaired by the Government. The Contractor shall demonstrate compliance with the review success criteria of GSFC-STD-1001, Criteria for Project Flight Critical Milestone Reviews, as applicable to spaceflight instruments. The Contractor shall respond as required to action items assigned by the Government. The Contractor shall work with the Government project and review team an additional day following all reviews to discuss and address issues raised and actions assigned at the reviews. The Government will convene a delta review if the success criteria for a review are not met to the Government's satisfaction. The Contractor shall prepare and present their portion of these reviews, as appropriate.

1.2.1.1 Instrument Reviews

The Contractor shall host, prepare and present instrument reviews and provide review packages in accordance with the stated CDRL. If multiple imaging sensors are developed to meet the requirements of this contract, then the Contractor shall conduct the following reviews for each sensor.

- Instrument System Requirements Review (ISRR), CDRL RE-1
- Instrument Integrated Baseline Review (IIBR), CDRL RE-8 (See para. 1.9)
- Instrument Preliminary Design Review (IPDR), CDRL RE-2
- Instrument Critical Design Review (ICDR), CDRL RE-3
- Instrument Pre-Environmental Review (IPER), CDRL RE-4
- Instrument Pre-Ship Review (IPSR), CDRL RE-5

The Contractor shall assume that each review requires four days to complete. The Contractor shall conduct dry runs of all Instrument Reviews with the Government approximately one week in advance of the reviews. The Contractor shall host and work with the Government project and review team an additional day following all instrument reviews to discuss and address issues raised and actions assigned at the reviews. The Government will convene a delta review if the success criteria for a review are not met to the Government's satisfaction. The Contractor shall host these delta reviews, and prepare and present these reviews. For proposal purposes, the Contractor shall assume one delta review will be required during the contract duration.

1.2.1.2 Spacecraft Reviews

The Contractor shall participate in and support the spacecraft contractor in preparation for the following spacecraft reviews:

- Spacecraft System Requirements Review (SSRR)
- Spacecraft Preliminary Design Review (SPDR)
- Spacecraft Critical Design Review (SCDR)

The Contractor shall assume four days of attendance at the spacecraft contractor's facility for each review and shall present a subset of the Instrument SRR, PDR, and CDR, respectively (updated as appropriate), with emphasis on instrument interfaces to the spacecraft.

1.2.1.3 Mission Operations Element Reviews

The Contractor shall participate in and support the MOE contractor in preparation for the following Mission Operations Element (MOE) reviews:

- MOE Requirements Review
- MOE Preliminary Design Review
- MOE Critical Design Review

The Contractor shall present instrument command and telemetry information and other material as appropriate. The Contractor shall assume four days of attendance at each review at the MOE contractor's facility.

1.2.1.4 LDCM Mission Level Reviews

The Contractor shall prepare and present a portion of Mission Level reviews and provide their portion of the review packages in accordance with CDRL RE-6:

- Mission Definition Review (MDR)
- Preliminary Design Review (PDR)

- Critical Design Review (CDR)
- System Integration Review (SIR)
- Pre-Environmental Review (PER)
- Pre-Ship Review (PSR)

The Contractor shall prepare and present a portion of the On-Orbit Acceptance Review in accordance with CDRL RE-9.

The Government leads these Mission-level reviews and will also be presenting material. The Contractor shall respond to action items as requested by the Government. The Contractor shall participate in dry runs of all Mission-Level Reviews with the Government approximately one week in advance of the reviews. The Contractor shall assume that the Mission-level reviews will take four days and that dry runs will take two days.

The Contractor shall also attend and support as necessary the following additional Mission-Level Reviews:

- Mission Operations Review (MOR)
- Flight Operations Review (FOR)
- Operational Readiness Review (ORR)
- Safety and Mission Success Review (SMSR)
- Flight Readiness Review (FRR)
- Launch Readiness review (LRR)
- Post-Launch Assessment Review (PLAR)
- Critical Event Readiness Review (CERR)

It is expected that these additional reviews require a lesser degree of preparation and participation by the instrument contractor than the other Mission-Level Reviews.

1.2.2 Engineering Peer Reviews

The Contractor shall define and implement a set of Engineering Peer Reviews (EPRs) for the hardware and software subsystems of the OLI instrument commensurate with the scope, complexity and acceptable risk of the product. The Contractor shall submit the Engineering Peer Review Plan in accordance with CDRL PM-5.

The Contractor shall chair and host EPRs at the Contractor's facilities with Government participation on the review panels. The Contractor shall document EPRs in accordance with CDRL RE-7, Engineering Peer Review Data Packages. The Contractor shall systematically and comprehensively peer review the product at the individual subsystem level, software module level, and at component ("box") and lower levels of assembly, as appropriate. In addition, packaging reviews shall be conducted on all electrical and electromechanical components in the flight system. Subsystem and component level design reviews (e.g., Telescope Critical Design Review (CDR), Calibration Assembly

CDR, Flight Software PDR, etc.) are considered to be EPRs and subject to this procedure. The Contractor shall conduct multiple peer reviews, as appropriate, over the lifecycle of each subsystem and component, with content consistent with the evolving design and development. As a minimum, the Contractor shall complete a comprehensive set of subsystem or lower-level peer reviews prior to instrument PDR and again prior to instrument CDR. Successful completion of these Pre-IPDR and Pre-ICDR EPRs and resolution of associated technical issues and actions is considered to be an important aspect of entry criteria in the formal review process. The Contractor shall also use EPRs for the focused evaluation of concepts, designs, plans and processes associated with combinations of subsystems and system functions and performance that cross traditional subsystem or discipline boundaries. Examples include fault detection and correction; or solutions to address, for example, pointing, thermal or contamination constraints.

Requirements for additional Software Peer Reviews are covered in section 4.1.7.2.3 of this SOW.

In addition to other standard discipline EPRs, the Contractor shall, as a minimum conduct EPRs to cover the following specific items:

1. Sensor focal plane assembly
2. OLI data system, including the allocation of functions between the Instrument and the spacecraft solid state recorder
3. Algorithm development
4. Mechanism design and test procedures
5. Optomechanical design and alignment processes
6. Sensor calibration design and test
7. Instrument integration and test (I&T)
8. Observatory-Level I&T
9. Fault detection and correction
10. Flight software development
11. Command and control procedures
12. System engineering and interfaces

The Contractor shall track action items from EPRs and maintain EPR presentation and closure documentation for the duration of the contract.

1.2.3 Other Reviews and Meetings

In addition to the established meetings required in this section, the Contractor shall support routine informal meetings and telecons with the Government as necessary. For proposal purposes, the Contractor shall assume two informal three-hour meetings per week at the Contractor's facility and five one-hour telecons.

1.2.3.1 Scheduled Weekly Telecons

The Contractor shall participate in a scheduled weekly telecon with the LDCM Project Office to communicate status, issues, and schedule progress and plans of the overall contract effort. The Contractor shall distribute meeting minutes, including the action item log, and other documentation as required. The minimum Contractor attendance shall consist of the Project Manager and Systems Manager or the appropriate technical lead managers as required. The Contractor shall provide detailed status, description of issues, and schedule updates for each major element of the contract.

1.2.3.2 Monthly Project Status Reviews

The Contractor shall communicate the status of the technical effort, program schedule, and resource condition to the LDCM Project on a monthly basis. The Contractor shall conduct Monthly Project Status Reviews (MPSRs), including a presentation package, in accordance with CDRL PM-1. The MPSR shall include Integrated Master Schedules (IMS) prepared in accordance with CDRL PM-2. The MPSR shall be conducted face-to-face at the Contractor's site unless otherwise agreed to in advance. The Contractor shall host and participate in splinter meetings with the Government for one additional day immediately following MPSRs, if required.

1.2.3.3 Technical Interchange Meetings and Working Groups

The Contractor shall inform the Government at least one week in advance of Contractor-initiated technical interchange meetings.

The Contractor shall participate in Government-led working groups. Planned Government-led working groups requiring OLI Contractor participation include, but are not limited to, a calibration/validation group, a systems engineering group, an integration and test group, a mission operations group, a safety working group, a reliability working group. The Contractor shall assume for planning purposes participation in six working groups, each requiring support equivalent two 2 person-days per month.

1.2.3.4 Status and Planning Meetings

The Contractor shall notify and allow the Government access to Contractor status and planning meetings, including daily stand-ups and tag-ups.

1.2.3.5 Focal Plane Array Status Telecon

The Contractor shall conduct a weekly telecon and occasional face-to-face meetings with the focal plane array contractor(s) and the Government. The weekly FPA status telecon shall cover: plans and status of FPA schedule, development, manufacturing, qualification, and test, and FPA issues and concerns.

1.3 Action Item Tracking

The Contractor shall develop and apply a process for capturing and responding to action items assigned by the Government. Instrument milestone reviews, as defined above, are not complete until actions are complete or, at the discretion of the Government, a detailed plan for closure is submitted by the Contractor and approved by the Government.

1.4 Electronic Access

The Contractor shall provide to the Government and Government contractor personnel, for review purposes, access via remote desk-top computer to a secure restricted-access general purpose OLI-specific electronic library. This library shall contain all completed documents, including but not limited to: reports, analyses, requirements documentation, internal technical memoranda, change requests and documentation, CDRLs, and all other OLI-specific documents prepared by the Contractor. Within the library, the Contractor shall maintain an index of the material (updated monthly) and a search engine for document access. The non-CDRL material contained in these electronic databases may be in Contractor format. The Contractor shall make the contents of the electronic library remotely downloadable. The Contractor may include engineering drawings in this library, but if not, the Contractor shall provide some other electronic storage/retrieval arrangement.

1.5 Internal Technical Memoranda

The Contractor shall provide all OLI-relevant technical internal memoranda as requested by the Government in accordance with CDRL SE-2, Contractor Generated Internal Technical Information. The correspondence may be informal to preserve timeliness. The Government shall have access to these memoranda on a timely basis via hard copy or the electronic library described in Section 1.4.

1.6 Access to Controlled Facilities

The Contractor shall obtain all required access authorizations and submit any paperwork required for the Contractor to access Government controlled facilities, such as the Mission Operations Center, and contractor controlled facilities, such as the spacecraft and MOE contractors' facilities. The Contractor shall allow access by the Government to all Contractor facilities used by OLI.

1.7 Risk Management

The Contractor shall establish and maintain a comprehensive risk management program. The Contractor shall generate a top risk report that is presented and reviewed at all Monthly Project Status Reviews (MPSRs). The Contractor shall provide an estimate of the potential cost impact if risks were to become real problems. The Contractor shall invite the Government to attend Contractor Risk Management Board meetings. The Contractor shall develop and implement a project-specific Risk Management Plan (RMP), in accordance with CDRL PM-12, as a means to anticipate, mitigate and control risks and to focus project resources to ensure success of the project.

The primary activities of the Contractor Continuous Risk Management (CRM) process are:

- a. Search for, locate, identify, and document reliability and quality risks before they become problems.
- b. Evaluate, classify, and prioritize all identified reliability and quality risks.
- c. Develop and implement risk mitigation strategies, actions, and tasks and assign appropriate resources.
- d. Track risk being mitigated; capture risk attributes and mitigation information by collecting data; establish performance metrics; and examine trends, deviations, and anomalies.
- e. Control risks by performing: risk close-out, re-planning, contingency planning, or continued tracking and execution of the current plan.
- f. Communicate and document (via the risk recording, reporting, and monitoring system) risk information to ensure it is conveyed between all levels of the project.
- g. Report on outstanding risk items at all management and design reviews.

The GSFC Project Office, the GSFC SRO (for design reviews only), and the Instrument Contractor will agree on what level of detail is appropriate for each review.

Although not all risks will be fully mitigated, the Contractor shall address all risks with mitigation and acceptance strategies agreed upon at appropriate mission reviews.

The Contractor shall document the project-specific implementation of the CRM process in a RMP in accordance with CDRL PM-12. Preparation of the RMP is a requirement established by NPR 7120.5 and includes the content shown in NPR 8000.4, "Risk Management Procedural Requirements."

The Contractor shall document and report all identified risks in accordance with the project's RMP. The Contractor shall address identified risk areas at project status reviews and at Integrated Independent Reviews (GPR 8700.4). The Contractor shall make risk status available to all members of the project team for review. Although not all risks will be fully mitigated, the Contractor shall address all risks with mitigation and acceptance strategies agreed upon at appropriate mission reviews.

The Contractor shall maintain a Risk List throughout the project life cycle, along with programmatic impacts. The list should indicate which risks have the highest probability, which have the highest consequences, and which risks represent the greatest risk to mission success. The list should also identify actions being taken to address each specific risk. The Contractor shall maintain the Risk List under configuration control.

For each primary risk (those having both high probability and high impact/severity), the Contractor shall prepare and maintain the following in the risk sections of the Program/Project Plans:

- Description of the risk, including primary causes and contributors, current mitigation strategy, and information collected for tracking purposes.
- Primary consequences should the undesired event occur.
- Estimate of the probability of occurrence (qualitative or quantitative) together with the uncertainty of the estimate and the effectiveness of any implemented risk mitigation measures.
- Potential additional risk mitigation measures, which shall include a comparison of the cost of risk mitigation versus the cost of occurrence multiplied by the probability of occurrence.
- Characterization of a primary risk as “acceptable” shall be supported by a rationale (with the concurrence of the GSFC LDCM Project Office) that all reasonable mitigation options (within cost, schedule, and technical constraints) have been instituted.

1.8 Problem tracking

The Contractor shall develop a closed-loop problem tracking process that includes problem or anomaly reporting, problem analysis, and corrective action. The process shall include: a protocol to review past performance to determine the incidence of identical or related anomalies, an escalation procedure (to inform higher levels of management and the Government) based on mission criticality, and a closeout process for root cause determination, anomaly mitigation, and recurrence control.

1.9 Resource Management

The Contractor shall establish, implement, and maintain a comprehensive resource management system for planning, authorizing, and controlling the total resources effort for each task and for providing timely and adequate visibility into manpower and schedule performance. The system shall be consistent with the Contractor’s standards.

The Contractor shall implement an Earned Value System (EVS). The Contractor shall provide an Earned Value System Management Plan in accordance with CDRL PM-6. The EVS may be implemented in accordance with the Contractor's standard plans and policies, provided it includes use of NASA Form 533 reports. The Contractor shall provide Financial Reports and Cost Performance Reports to the Government in accordance with CDRLs PM-7 and PM-8 and the contractor's standard policies and procedures. The Contractor shall conduct an Integrated Baseline Review at the Contractor facility and present data in accordance with CDRL RE-8. The Contractor shall obtain approval from the Government prior to changing the EVM baseline. The Contractor shall provide technical data to support the Government's development and updating of the Project Cost Analysis Data Requirement (CADRE) in accordance with CDRL PM-3, CADRE Data.

The Contractor shall establish, implement, and maintain an integrated scheduling system consistent with their corporate procedures and documented in a schedule management plan. The Contractor shall provide and maintain an Integrated Master Schedule (IMS) in accordance with CDRL PM-2. The Contractor shall obtain approval from the Government prior to changing the IMS baseline.

The Contractor shall provide the necessary resources for monitoring, controlling, executing, and administering the OLI contract and subcontracts to ensure compliance with all contractual requirements.

1.10 Configuration Management

The Contractor shall perform configuration management (CM) in support of the OLI project. The Contractor shall develop and deliver the Hardware and Software Configuration Management Plan in accordance with CDRL PM-10. The Contractor shall notify the Government of CCB meetings and allow Government participation at all CCB meetings. The Contractor shall maintain configuration of flight hardware and software, at a minimum, throughout all phases of assembly and test. The Contractor shall perform and document configuration verification as parts and assemblies are incorporated into higher-level assemblies and at major Project milestones (e.g., pre-environmental test, pre-ship, pre-launch, etc). The CM system shall have a change classification and impact assessment process that results in Class 1 and Class 2 Configuration Change Requests (CCRs) being forwarded to the LDCM Project in accordance with CDRL SE-1, Engineering Change Requests, Deviations, and Waivers.

The Contractor shall submit for Government consideration a waiver or deviation for any flight item that is found to be non-compliant with the requirements of the contract Statement of Work (SOW) or the MAR and is not reworked to be compliant, or is not replaced with a compliant item.

The Contractor shall prepare and provide, as a minimum, the following configuration control documentation:

1. Configuration Control Board (CCB) status shall be reported at the Monthly Project Status Review in accordance with CDRL PM-1.
2. Engineering Drawings in accordance with CDRL SE-5.
3. The Configuration Item Identification List (CIIL) and the Computer Software Configuration Items (CSCIs) in accordance with CDRL SE-8.

1.11 Government Resident Office Support

The Contractor shall provide facilities to support two Government in-plant representatives at the instrument development/build site, including office space, furniture, facsimile machine, office supplies, file/storage area, telephones, network access to the Contractor's electronic database, and access to a copier and a dedicated conference room from contract award through observatory on-orbit acceptance. The Contractor shall provide within these offices high-speed (broadband) internet access and access to an ISP (Internet Service Provider) outside the Contractor's facility to allow for access to the GSFC and USGS network. The Contractor shall accommodate the two in-plant representatives in securable offices.

The Contractor shall provide additional work space, furniture, phones, and high-speed internet access with access to an outside ISP for an additional two visiting Government representatives from contract award through observatory on-orbit acceptance.

2 Systems Engineering

The Contractor shall perform systems engineering to support all OLI-related activities during all stages of development. For costing purposes, the duration of Systems Engineering shall be until on-orbit acceptance. Systems Engineering activities after final on-orbit acceptance of OLI shall be as specified within section 6.0.

The systems engineering effort shall include, but is not limited to, analyses of technical requirements, functional and performance allocation of derived requirements, traceability, definition and maintenance of all interfaces, OLI design and verification of all defined, allocated, and derived requirements, systems analyses and special studies as required, risk management support, and tradeoff analyses. This shall include but not be limited to the following specific activities:

- a. Providing technical direction and oversight throughout all phases of the program.
- b. Leading and supporting all peer reviews, project milestone, gateway and launch reviews, and program status reviews as defined in section 1.2.
- c. Performing all necessary system studies and trades and risk assessments necessary to develop the OLI design.
- d. Performing all necessary coordination, studies and analyses required to interface the OLI to the LDCM spacecraft, including OLI-specific support to ground system requirements development and operations.
- e. Preparing documentation and providing necessary support for reviews defined in section 1.2.
- f. Performing systems engineering and analysis in support of instrument tests at the Observatory level and launch site.
- g. Supporting system level technical interface meetings, including technical issue resolution, performance verification plan buy-offs, pending configuration change requests (CCR's), CDRL data submission review/approval status, test data review, anomaly resolution activities, and test support planning.

The Contractor shall develop, in accordance with CDRL SE-33, a Systems Engineering Management Plan which describes the Contractor's systems engineering approach and processes to be used on the LDCM project.

2.1 Requirements Analyses, Derivations, and Allocations

The Contractor shall provide the definition, allocation, derivation, and traceability of system and subsystem requirements and the verification approach.

The Contractor shall conduct complete analyses and simulations in support of technical requirements compliance demonstrations to fully establish, define, maintain, and control allocations for all required performance and design parameters. Allocations shall

include, but are not limited to, mass properties, power, alignment, line-of-sight pointing, contamination, and on-board processor resources.

The Contractor shall perform and document requirements analyses and allocation tasks, including the following as a minimum:

1. Flow-down and traceability of OLI system requirements.
2. Functional and performance allocations and derivations.
3. Developing the Instrument Operations Concept in accordance with CDRL SE-14.
4. Maintaining and controlling OLI technical performance metrics, margins, budgets, and Key Technical Parameters which are reported at the Monthly Program Status Review. The Contractor shall include Key Performance Requirements as a subset of Key Technical Parameters.
5. Preparing the OLI Mass Properties Reports in accordance with CDRL SE-32.
6. Defining the number and hierarchy (sub-modes) of the various instrument operating modes.
7. Developing the Beginning of Life (BOL) design performance requirements given that the requirements of the OLI Requirements Document are for End of Life (EOL) and documenting the supporting analyses in CDRL SE-31, OLI Performance Margin Analyses.

2.2 Interface Definition, Verification and Control

The Contractor shall meet the interface requirements of the LDCM Observatory Interface Requirements Document and shall satisfy the specifications found within the Spacecraft to Operational Land Imager Interface Control Documents (ICDs). Unlike a requirements document, the Spacecraft to OLI ICD documents are expected to undergo several releases as the interface information evolves with increased detail and accuracy commensurate with observatory development. The Contractor shall support the development and maturation of the ICDs through data submittals in accordance with CDRL SE-13. The Contractor shall verify the OLI side of the interface as documented in the ICDs and shall assist the Government in evaluating the spacecraft contractor's verification of the interface. The Contractor shall complete a Performance Verification Plan and Matrix for the ICDs and submit it under CDRL SE-6 "System Performance Verification Plan and Matrix." The ICD Verification Plan may comply with a subset of the SE-6 CDRL requirements as agreed upon with the Government.

The Contractor shall perform necessary analyses and participate with the Government in the further definition of OLI to spacecraft interfaces, including but not limited to the following:

- a. Data Volume
- b. Data Interface (data handling, modes, compression, etc.)
- c. Mechanical Interface
- d. Thermal Interface

- e. Electrical Interface
- f. ACS Sensors Accommodation/Pointing/Stability/Alignment/Co-alignment/Allocations
- g. Fields of view
- h. Test Planning (as relates to spacecraft requirements)

Contractor participation shall include, but is not limited to, meetings, telecons, and reviews, providing comments on analyses and reports, and providing independent analyses.

It is the Government's intention to issue trade study contracts with several spacecraft contractors prior to spacecraft bus selection. During this trade study period, there will be an opportunity to firmly establish interface requirements between the spacecraft and the instrument. To this end, the Contractor shall document and provide the latest instrument interface estimates in accordance with CDRL SE-11, Instrument Interface Information. The Contractor shall then support the Government in answering spacecraft interface questions from the study vendors.

2.3 Design and Performance Verification

The Contractor shall design the OLI system.

The Contractor shall develop and maintain all necessary plans and procedures to verify that the OLI meets all requirements described in the OLI Requirements Document and the LDCM IRD. The Contractor shall develop and deliver the Specification Tree in accordance with CDRL SE-12. The Contractor shall also perform and document all analyses of the data and information from the design, development, qualification testing, acceptance testing, compatibility testing, and on-orbit testing of the Contractor's hardware and software which are required to ensure that the OLI program will meet its specifications and objectives. These tasks include, but are not limited to the following:

1. Preparing and maintaining the System Performance Verification Plan and Matrix (CDRL SE-6) for use at the component, subsystem, and instrument levels of assembly, and including spacecraft integration and interface verification.
2. Analyzing and making available for inspection the required lower-level design specifications in order to meet higher-level performance requirements (e.g., what detector D* should be specified in order to meet system Signal to Noise Ratio). All such analyses shall be identifiable and accessible for Government review.
3. Preparing and maintaining verification test procedures for use at the component, subsystem, instrument, and observatory level of assembly, including instrument-to-spacecraft integration and interface verification.
4. Providing the necessary effort and support systems for data reduction and analysis during all levels of testing, interface verification, spacecraft-level testing, and during on-orbit testing.

5. Developing and delivering the Calibration/Validation Plan in accordance with CDRL CV-1.
6. Conducting test evaluation and test reporting.
7. Providing an Instrument Users Manual in accordance with CDRL OO-2.

2.4 Systems Analyses

The Contractor shall perform the necessary systems engineering analyses to assure that all requirements of this contract are accomplished successfully and on time. These systems engineering analyses shall include, at a minimum, the following;

1. Visible and shortwave infrared radiometry
2. Spectral performance
3. Perform a flowdown of the performance requirements to the Focal Plane Array (FPA), and an analysis of the FPA design to demonstrate that the FPA will be able to meet its requirements with sufficient margin.
4. Optics, including stray light (including stray light from spacecraft and all reflected sources)
5. Line of sight jitter, including contributions from both the instrument and spacecraft
6. Pointing knowledge and error budget of the entire instrument and spacecraft (Observatory) system
7. Data system throughput, storage, and playback analyses
8. Polarization sensitivity
9. Optical alignment design, tolerances and error budget
10. CPU loading, input and output loading, disk utilization, and memory loading for all ADPE.
11. Structural Thermal Optical Performance (STOP) analysis of the instrument and review and comment on STOP analysis performed for the Observatory.

These and all other analyses performed by the Contractor under this contract shall be available to the Government for review.

The Contractor shall develop and deliver the Jitter Analysis Report and the Radiometric Analysis Report in accordance with the CDRL SE-17, Analyses Reports.

2.5 Trending

The Contractor shall establish a method for trending test data during instrument and Observatory level testing. The trending method may be different for instrument level testing versus observatory level, but the preferred method at observatory level is to utilize the Government-provided operational trending system. The Contractor shall coordinate with the Government the selected list of parameters to be trended in accordance with CDRL SE-3, Trend Analysis and Operations Log. The Contractor shall monitor selected parameters for trends starting at the beginning of instrument electrical integration and

continuing during the system integration and test phases through the on-orbit commissioning phase. The Contractor shall analyze the trended data for indications of anomalous conditions and for possible performance or reliability degradation. The Contractor shall provide Trending Reports and operating hours in accordance with CDRL SE-3, Trend Analysis and Operations Log. The Contractor shall use the operational trending system to perform trending on orbit. The Contractor shall coordinate with the Government the list of parameters to be trended on orbit using the operational system. The Contractor shall support the development and validation of the Mission Operations Element operational trending system by participation in telecons and review and comment on documentation.

The Contractor shall present a matrix of the components being trended at the IPER. The Contractor shall present the trend data during the IPSR and PSR. Additionally, during the IPER, the Contractor shall define for each parameter trended how the data are analyzed and interpreted with respect to the allowable test limits of the data as the testing progresses through the test phases. The Contractor shall notify the Government of any anomalous changes and/or trend(s) in the data and shall be explained during the IPSR and PSR. The Contractor shall establish a system for recording and analyzing the parameters as well as any changes from the nominal even if the levels are within specified limits. The Contractor shall review all trending results from every phase of the development with the Flight Operations Team prior to launch.

2.6 Special Studies

The Contractor shall conduct, in addition to the requirements specified in this document and the contract, additional engineering studies, tests, technical analyses, reviews of test results, design modifications, and tasks relating to the development, implementation, characterization, and operation of the OLI, as authorized by the Government and in accordance with Contract Clause C.2. Each task will be initiated by written direction from the Government contracting officer. The Government will coordinate with the Contractor to define each task in detail, and establish manpower ceilings, performance schedules, and deliverables.

3 Mission Assurance

The Contractor shall develop, implement, and maintain a comprehensive mission assurance program which meets the requirements of the Instrument MAR (GSFC 427-03-03). The Contractor shall adhere to the requirements of the MAR, perform all tasks required by the MAR, and deliver all documents and data required by the MAR.

4 LDCM Instrument Development

The Contractor shall develop the OLI in accordance with all contract requirements.

4.1 Design Engineering

The Contractor shall provide all necessary personnel, facilities, services, and materials to design the OLI in accordance with its design specifications. The Contractor shall make available for review by the Government design specifications for all subcontracted and purchased items.

The Contractor shall develop and deliver the Instrument Design Specification for the OLI in accordance with CDRL SE-9. Because the requirements in the OLI Requirements Document are specified at End of Life (EOL), the Government will use the OLI Design Specification Beginning of Life (BOL) values to determine both conditional acceptance and on-orbit acceptance.

4.1.1 Focal Plane Assembly Design

The Contractor shall design the instrument focal plane assembly, including the bandpass filters and focal plane electronics. The Contractor shall perform an analog amplifier analysis (stage-by-stage, each channel to include SNR, bandwidth, gain, stability, etc.)

4.1.2 Telescope and Optics Design

The Contractor shall design the instrument telescope, including the metering structure, and other instrument optics.

4.1.2.1 Optical Analytical Model

The Contractor shall develop, deliver, and maintain an Optical Analytical Model in accordance with CDRL CV-5. The Contractor shall verify the accuracy of the model with hardware testing. The Contractor shall update the model to agree with the test results.

4.1.2.2 Stray Light and Ghosting Model

The Contractor shall develop and maintain the Stray Light and Ghosting Model in accordance with the Special Calibration Test Requirements document (GSFC 427-05-04) and make the model available for review at the Contractor's facility. Starting at ICDR,

the Contractor shall notify the Government of revisions to the Stray Light and Ghosting Model and make these revisions available for Government review at the Contractor's facility.

4.1.3 Instrument Electronics Design

The Contractor shall design the instrument electronics. The Contractor shall perform a Signal Integrity Analysis of all electronics cards in which the level of detail is consistent with the speed of the logic families selected in relation to the transmission line characteristics of the physical implementation.

4.1.4 Instrument Structure Design

The Contractor shall design the instrument structure. The Contractor shall deliver the Structural and Mechanical Subsystem Performance and Analysis Report and the Stress Analysis Report in accordance with CDRL SE-17, Analyses Reports. The Contractor shall perform an analysis of bearing-to-housing fits, tolerances, and thermal effects. The Contractor shall perform a modal analysis showing survival of boards and components.

The Contractor shall develop and deliver Structural and Dynamic Models and Model Verification Plan in accordance with CDRL SE-16. The Contractor shall verify the accuracy of the models with dynamic test data. The Contractor shall update the models to agree with the structural test results.

4.1.5 Mechanisms Design

The Contractor shall design the instrument mechanisms, including mechanisms required in the calibration system. The Contractor shall perform torque analyses for all motors, torsional springs, and mechanisms.

4.1.6 Calibration System Design

The Contractor shall design the instrument calibration system.

4.1.6.1 Calibration Algorithms and Parameters

The Contractor shall develop and deliver Calibration Algorithms and Parameters in accordance with CDRL CV-6.

4.1.6.2 Radiometric Math Model

The Contractor shall develop, deliver, and maintain a Radiometric Math Model in accordance with CDRL CV-4.

4.1.7 Flight Software Design

The Contractor shall design the OLI flight software.

4.1.7.1 Software Definitions

4.1.7.1.1 Flight Software

Flight Software (FSW) for the OLI includes embedded real-time software, flight firmware found in the on-board microprocessor(s) and/or embedded in the various OLI hardware subsystems. Functions provided by the FSW include but are not limited to: real-time operating system, time management, instrument processing, telemetry monitoring, command storage and execution, failure detection and correction, and memory management. Flight Software also encompasses all non-deliverable, on-board microprocessor(s) software used in support of testing the Flight Software.

The Contractor shall treat the software component of firmware, which consists of computer programs and data loaded into a class of memory that cannot be dynamically modified by the computer during processing (including Programmable Read-Only Memories (PROMs), programmable logic arrays, digital signal processors, Field Programmable Gate Arrays (FPGAs), VHSIC (Very High Speed Integrated Circuit) Hardware Description Language (VHDL) etc.) as flight software for the purposes of this SOW. For any software that executes on the flight unit that is autogenerated from databases, models or other sources, the Contractor shall consider that software as Flight Software for the purposes of this SOW.

For all flight software elements, the Contractor shall demonstrate compliance with the NASA Software Engineering Requirements specified in the NPR 7150.2. These documents provide the minimal set of requirements established by the Agency for software acquisition, development, maintenance, operations, and management. The Contractor shall implement MAR requirements with respect to Software Assurance.

The Contractor shall develop, verify, validate and maintain the complete FSW image in the OLI and associated testbeds for the duration of the contract.

4.1.7.1.2 Software Development and Validation (SDV) Software

The Contractor shall develop the Software Development and Validation environment for the OLI which supports the development and test of the Flight Software. It includes host

development computer operating systems, high-level language compilers and debuggers, autocode generator software systems, machine language emulators, and test scenarios and procedures. It includes the software in the OLI test environment simulators that model the detectors and mechanisms. It also includes development support software such as document and code configuration management systems.

4.1.7.1.3 Software Criticality Classification

The Contractor shall classify all OLI Flight and SDV software as belonging to one of the following criticality classifications and shall define the management approach of each class in the Software Management and Development Plan (SMDP) (CDRL SW-8):

- (a) Mission Critical
- (b) Mission Support
- (c) Engineering Analysis
- (d) Commercial

(d)1. Commercial software acquired for integral use within planned operational elements shall be assigned a criticality equal to that of the element of which it is a part.

These software classifications are defined in the LDCM Acronym List and Lexicon (GSFC 427-02-06).

The Contractor shall classify all OLI software within the Flight and SDV Elements as belonging to one of the following types of software and shall define the management approach of each class in the Software Development and Management Plan (SDMP):

- (a) Developed
- (b) Reuse
- (c) Heritage
- (d) Off-the-Shelf (OTS)

(d)1. OTS software is further defined as Commercial-Off-the-Shelf (COTS), Modified-Off-the-Shelf (MOTS) software, and Government-Off-the-Shelf (GOTS) software.

These software types are defined in the LDCM Acronym List and Lexicon (GSFC 427-02-06).

The Contractor shall meet the requirements of NASA Software Engineering Requirements specified in the NPR 7150.2 when choosing to use OTS software to satisfy all or part of the software requirements implementation. The details of OTS utilization and management of such shall be provided in the Contractor's SDMP.

4.1.7.2 Software Management, Requirements, Development, Verification, and Testing

The Contractor shall document in the Software Development and Management Plan (SDMP) document, in accordance with CDRL SW-8, the software management approaches and processes for software analysis, design, development, documentation, version control, test, validation, risk management, metric collection, and assurance of all software products. The Contractor shall adhere to the SDMP.

4.1.7.2.1 Planning and Requirements Life Cycle Activities

The Contractor shall perform all analyses and software systems engineering required to identify and allocate (from system and subsystem requirements) software requirements and shall generate the Software Requirements Specification (SRS) in accordance with CDRL SW-1. The Contractor shall ensure that all requirements are forward and backward traceable between system and software requirements and between software requirements, design, and test.

The developer shall plan and implement a Verification and Validation (V&V) program to ensure that software being developed or maintained satisfies functional and performance requirements defined in the SRS. The Contractor's testing approach and methodology shall be documented in the Software Test Plan in accordance with CDRL SW-6 program. The Contractor shall address the approach to the following levels of testing on the flight software elements as identified in the Flight Software Test Plan:

- V&V of the logic of individual software functions while exercising all critical paths of the software unit.
- V&V of an integrated FSW build delivered to the FSW Test Team operates as designed and meets each functional and performance requirement allocated to the build.
- V&V of the FSW in its target hardware environment in a manner as close as possible to post-launch operations with the intent of qualifying the FSW as a mission subsystem – meeting all on-orbit nominal, anomalous and contingency operational requirements.
- Software acceptance testing is defined as the formal execution of a full set of FSW system validation tests against the final delivery of the FSW system.

The Contractor shall identify how all non-flight code resident in flight hardware is identified, and how it is removed from the flight hardware prior to delivery.

4.1.7.2.2 Design Life Cycle Activities

The Contractor shall maintain Algorithm Design Documents (ADD) for each OLI subsystem that incorporates flight software in its implementation. The Contractor shall

deliver the Software Design Document and Software Users Guide in accordance with CDRLs SW-2 and SW-3.

4.1.7.2.3 Software Reviews

The Contractor shall prepare and conduct flight software status reviews as part of the technical status portion of the Monthly Project Status Reviews as described in SOW Section 1.2.3.2.

Software TIMs shall be conducted with Government participation.

In addition to the Engineering Peer Reviews (EPRs) listed in SOW section 1.2.2, the Contractor shall conduct, at a minimum, the following software-specific EPRs:

- Software Requirements EPR
- FSW Acceptance Test Readiness Review (ATRR) and deliver a Software Test Readiness Review Data Package in accordance with CDRL SW-4
- Software Acceptance Review (SWAR) and deliver a Software Acceptance Review Data Package in accordance CDRL SW-5.

4.1.8 Harnessing Design

The Contractor shall design the instrument harnessing.

4.1.9 Electrical System Design

The Contractor shall design the instrument electrical system, including power handling and conversion, heaters, grounding and electrical isolation, and EMI/EMC control. The Contractor shall deliver an Electrical Systems Requirements Document in accordance with CDRL SE-18.

4.1.10 Thermal System Design

The Contractor shall design the instrument thermal system. The Contractor shall develop and deliver the Thermal Analysis Report in accordance with the CDRL SE-17, Analyses Reports.

The Contractor shall develop and deliver Thermal Math Models in accordance with CDRL SE-4.

4.1.11 Contamination Control Design

The Contractor shall incorporate contamination control into the instrument design.

4.1.12 Instrument Integration and Test Planning

The Contractor shall perform integration and test planning. The Contractor shall use Integration and Test discipline expertise throughout the product lifecycle.

The Contractor shall develop and deliver the Environmental Verification Plan and Environmental Test Matrix in accordance with CDRL IT-6.

The Contractor shall develop and deliver an Instrument Integration and Test Plan in accordance with CDRL IT-1.

The Contractor shall develop and deliver Detailed Test Procedures in accordance with CDRL IT-3.

4.1.13 Instrument Simulators Design

The Contractor shall design one OLI Interface Simulator and one OLI Simulator.

This section addresses the Simulators each as discrete items. The Contractor may, with Government approval, combine interface and simulator functions in one or more implementations which satisfy Simulator requirements. For example, the OLI Interface Simulator may, after testing with the spacecraft is successfully completed, be enhanced with operational features to become the OLI Simulator.

The Contractor shall report all simulator development status, issues, and anomalies in Engineering Peer Reviews, the PDR and CDR reviews, and review packages.

The Contractor shall provide all design and specification documentation used as the basis for development of the Instrument Simulators. The Contractor shall deliver as a minimum:

Instrument Simulator Specification, CDRL SE-21
Instrument Simulator Users Guide, CDRL SE-22
Instrument Simulator Interface Verification Report, CDRL SE-23
Instrument Simulator Test Plan, CDRL SE-24
Instrument Simulator Software Test Reports, CDRL SE-25
OLI Interface Simulator Specification, CDRL SE-26
OLI Interface Simulator Users Guide, CDRL SE-27
OLI Interface Simulator Interface Verification Report, CDRL SE-28
OLI Interface Simulator Interface Verification Plan, CDRL SE-29

OLI Interface Simulator Software Test Reports, CDRL SE-30

4.1.14 Engineering Development Unit Design

The Contractor shall design an OLI Engineering Development Unit (EDU) to evaluate design, test electrical/data interfaces, develop/validate flight software, mitigate risk, and to provide a test bed for anomaly resolution for the flight model components. The EDU is intended as a risk reduction development effort and shall, as a minimum, include a flight-like Focal Plane Assembly. The Contractor shall propose the appropriate level of development and fidelity of the EDU. The Contractor shall deliver an EDU Plan with the proposal in accordance with CDRL PM-9.

4.1.15 Data Processing Algorithms Design

The Contractor shall design the data processing algorithms.

4.1.15.1 Line-of-Sight Processing Algorithms

The Contractor shall demonstrate that the end-to-end requirements of section 5.7 of the OLI Requirements Document are satisfied by these algorithms. The Contractor shall document and deliver the results of the demonstration in accordance with CDRL CV-6, Calibration and Algorithm Parameters.

4.1.15.2 Data Processing Algorithms

The Contractor shall develop, deliver, and maintain Data Processing Algorithms (see OLI Requirements Document, Section 5 in accordance with CDRL CV-7.

4.1.15.3 Support to Operational Algorithm Development

The Contractor shall support the development of the operational algorithms to be used in Government LDCM operational data processing. The Contractor shall review and comment on Government algorithm implementation and testing. The Contractor shall assist in reconciling differences between Contractor-derived algorithm results (CDRL CV-7) and Government-derived algorithm results. The Contractor shall participate in TIMs and telecons as part of this effort.

4.2 Fabrication, Assembly, and Test

The Contractor shall provide all necessary personnel, facilities, services, and materials to fabricate, assemble, and test the OLI in accordance with its design specifications. “Fabrication” in this sense also includes procured items. The Contractor shall make

available for review by the Government test and acceptance reports for all subcontracted and purchased items.

4.2.1 Focal Plane Assembly Fabrication, Assembly, and Test

The Contractor shall fabricate, assemble, and test the instrument focal plane assembly, including the focal plane electronics. The Contractor shall develop and provide Focal Plane Array Documentation in accordance with CDRL SE-10.

4.2.2 Telescope and Optics Fabrication, Assembly, and Test

The Contractor shall fabricate, assemble, and test the instrument telescope and optics.

4.2.3 Instrument Electronics Fabrication, Assembly, and Test

The Contractor shall fabricate, assemble, and test the instrument electronics.

4.2.4 Instrument Structure Fabrication, Assembly, and Test

The Contractor shall fabricate, assemble, and test the instrument structure.

4.2.5 Instrument Mechanisms Fabrication, Assembly, and Test

The Contractor shall fabricate, assemble, and test the instrument mechanisms.

4.2.6 Instrument Calibration System Fabrication, Assembly, and Test

The Contractor shall fabricate, assemble, and test the instrument calibration system.

The Contractor shall fabricate, assemble, test, and install a replacement instrument solar calibration system.

4.2.7 Flight Software Development and Test

The Contractor shall develop, code, and test the instrument flight software.

4.2.7.1 Implementation and Delivery Life Cycle Activities

The Contractor shall implement the documented Hardware and Software Configuration Management Plan (CDRL PM-10) with respect to Flight Software Development and Test. All software elements (flight and ground test) shall be placed under Configuration

Management, including default and baseline values for tables and parameters used in the Ground Test Software and Flight Software.

To assist in the verification and validation of software requirements, the Contractor shall develop and maintain a Software Requirements Verification Matrix (SRVM). The SRVM shall be available to the government upon request.

The Contractor shall ensure that all deliverable computer systems show the following splash screen on initial turn-on, exiting of which shall require specific keyboard action by the operator (e.g. CTRL-ALT-DEL/OK/Enter/Cancel):

This system is for the use of authorized users only. By accessing and using this computer system you are consenting to system monitoring, including the monitoring of your keystrokes. Unauthorized use of, or access to, this computer system may subject you to disciplinary action and criminal prosecution.

The Contractor may enhance the display as appropriate, maintaining readability.

The Contractor shall document and maintain detailed testing procedures. Electronic versions of test procedures shall be available upon request to the Government. The Contractor shall document, verify and validate formal software tests through the Software Test Report in accordance with CDRL SW-5.

In the software acceptance test phase, the Contractor shall enable formal monitoring and/or auditing of software testing by Government personnel to include the NASA IV&V staff. Upon successful completion of this phase of testing, the Contractor shall close out all major action items, present a plan to resolve all residual actions, and prepare for formal delivery of the software.

The Contractor shall identify in the SRVM flight software requirements which require flight hardware for verification and validation during instrument and Observatory integration and test.

The Contractor shall ensure that both functional and performance test procedures execute the OLI flight software in all modes and configurations using the OLI flight hardware. The Contractor shall perform these tests on both primary and at least one redundant configuration. These tests will be used to verify performance during initial integration, environmental testing, pre-ship at the Observatory integration facility, post-ship at the launch facility, and on the launch vehicle. The Contractor shall design these tests to execute as much of the flight software code and data as is practical prior to launch.

4.2.7.2 Software Management Requirements

4.2.7.2.1 Software Measures (Metrics)

The Contractor shall acquire and include Software Measures (Metrics) as defined in the SDMP from any sub-contractors or team members.

The Contractor shall collect and report software measures supporting the analysis of both software product quality and schedule/effort/cost performance. The collection and reporting of metrics shall be automated to the fullest extent practical. Measures shall be provided to the Project both as raw data and in graphical form as part of the monthly status review.

4.2.7.3 NASA IV&V Support

The Contractor shall ensure that all software documentation and code required for the NASA Software Independent Verification and Validation (IV&V) effort is made available to NASA IV&V personnel. This includes access to all software reviews and reports, developer plans and procedures, software code, software design documentation, and software problem reporting data. Wherever possible, the Contractor shall permit electronic access to the required information or furnish soft copies of requested information to NASA IV&V personnel.

The Contractor shall review and assess all NASA IV&V findings and recommendations. The Contractor shall forward their assessment of these findings and recommendations to the LDCM Project Office. The Contractor shall take necessary corrective action based upon their assessment and notify the LDCM Project Office of this correction action. The Contractor shall also notify the LDCM Project Office of those instances where they decided not to take corrective action on specific IV&V findings and recommendations. A Contractor point of contact shall be assigned and available to NASA IV&V personnel, as required, for questions, clarification, and status meetings.

4.2.7.4 Software Maintenance

The Contractor shall develop and maintain the OLI Flight software and documentation, along with the environments, emulators, and test software necessary to develop and verify these systems through the duration of the contract.

The Contractor shall develop, certify, and maintain through OLI final acceptance the Software Development and Verification Facility (SDVF), which is a real-time closed loop flight software test bed facility. The Contractor shall develop the requirements of the SDVF and present these requirements and their rationale at the Software Requirements EPR. The Contractor shall keep the SDVF at their facility for the duration of the contract period.

The Contractor shall maintain any special hardware (non-commercial such as C&DH components and power supplies) in the SDVF for the duration of the contract.

The Contractor shall deliver the SDVF to the Government.

The Contractor shall demonstrate delivery of a flight software patch from the Contractor facility to the Government MOC prior to the Operations Readiness Review.

The Contractor shall deliver the Software Delivery Package and Updates in accordance with CDRL SW-7.

4.2.8 Harnessing Fabrication, Assembly, and Test

The Contractor shall fabricate, assemble, and test the instrument harnessing.

4.2.9 Electrical System Fabrication, Assembly, and Test

The Contractor shall fabricate, assemble, and test the instrument electrical system.

The Contractor shall perform EMI/EMC testing on the flight unit Instrument Support Electronics and the flight unit Focal Plane Electronics to the levels specified in the LEVR.

4.2.10 Thermal System Fabrication, Assembly, and Test

The Contractor shall fabricate, assemble, and test the instrument thermal system.

4.2.11 Contamination Control Monitoring and Validation

The Contractor shall monitor the instrument for contamination effects and validate instrument contamination controls.

4.2.12 Instrument Integration and Test

4.2.12.1 Integration

The Contractor shall integrate the instrument assemblies into a fully assembled OLI that is ready for performance and environmental testing.

4.2.12.2 Environmental and Performance Testing

The Contractor shall provide all personnel, facilities, services, and materials necessary to verify that the OLI meets its functional and performance specifications after exposure to the environments required by the LDCM Environmental Verification Requirements (GSFC 427-03-05).

The Contractor shall execute the approved Environmental Verification Plan and the approved Integration and Test Plan using the fully integrated OLI subsystems in as near a flight-like mechanical configuration as is practicable, and operating the launch, safe-hold, and nominal configurations, as appropriate.

The Contractor shall develop and deliver Test Reports in accordance with CDRL IT-2.

The Contractor shall provide Verification Reports in accordance with CDRL SE-7.

The Contractor shall deliver Instrument Data Sets in accordance with CDRL CV-9.

The Contractor shall document and investigate anomalies and perform anomaly resolution. The Contractor shall notify the Government of anomalies within 24 hours of occurrence. The Contractor shall store and maintain all output data collected during testing for anomaly resolution. Anomaly resolution is the identification, investigation, and resolution of anomalies including the characterization of a problem or deficiency, determination of the probable cause or missing functionality, evaluation against existing specifications and requirements, and providing analysis to the Government for prospective corrective actions or enhancements.

The Contractor shall allow Government personnel access to all released and as-run test procedures, test conductor log books and electronic command logs; testing; and test planning meetings.

The Contractor shall deliver the As-Run Test Procedures in accordance with CDRL IT-5.

4.2.12.3 Instrument Calibration

The Contractor shall develop and provide the Calibration and Validation Plan in accordance with CDRL CV-1. The Contractor shall implement the Calibration and Validation Plan. The Contractor shall calibrate the OLI in accordance with the Government-approved Contractor-developed Calibration and Validation Plan. The Contractor shall implement the requirements of the Special Calibration and Test Requirements Document. The Contractor shall provide Calibration/Validation Procedures, for every calibration/validation test described in CDRL CV-1, in accordance with CDRL CV-2. The Contractor shall provide Calibration/Validation Reports in accordance with CDRL CV-3. The Contractor shall provide Calibration/Validation

Summary Reports in accordance with CDRL CV-3. In addition, the Contractor shall provide Relative Spectral Response (RSR) Component Measurements and System RSR Analysis in accordance with CDRL CV-8. The Contractor shall provide spectral filter witness samples that were fabricated at the same time, using the same process, as the flight spectral filters, and are a minimum of one-inch diameter, to the Government in accordance with Contract attachment B.1.

4.2.12.4 Instrument Independent Testing

To maintain continuity of the Landsat data archives and calibration to the National Institute of Standards and Technology (NIST), the Contractor shall provide access to the Contractor's radiometric calibration sources sufficient for the Government and Government contractors to conduct source characterization at the Contractor's facility. The Contractor shall also provide coordination and support sufficient for the Government and/or its Contractors to conduct independent pre-launch measurements of the Contractor's radiometric calibration sources at the Contractor's facility.

For Government Transfer Radiometer testing, the Contractor shall provide access sufficient for the Government and/or its Contractors to conduct source characterization in the Contractor's laboratory environment. For planning purposes this shall be assumed to consist of a total of five 2-day periods: three 2-day periods prior to sensor calibration; and two 2-day periods after sensor calibration. In addition, the Contractor shall provide access sufficient for the Government and/or its Contractors to conduct source monitoring during Sensor calibration activities.

The Contractor shall provide access and support for NIST/Earth Observing System (EOS) radiometric scale realization activities. For planning purposes this shall be assumed to consist of two 4-day periods: one prior to sensor calibration with the calibration source and one after sensor calibration. The radiometric scale realization activities will involve viewing of the radiometric calibration source(s), typically large aperture integrating spheres, used by the Contractor to calibrate the OLI. These sources will be viewed by a number of transfer radiometers and the results will be compared to the Contractor's calibration of this source. The Contractor shall supply access to and an operator for the radiometric calibration source as well as the current radiometric calibration of this source.

The Contractor shall account for these Independent Testing periods of access in the contract and program schedule. The Government will provide reasonable notice of these periods of access.

4.2.12.5 Instrument Level of Assembly on Delivery

The Contractor shall deliver to the spacecraft vendor an OLI that is fully assembled and can be handled as a whole, single unit, requiring no reassembly of OLI subsystems during observatory integration that would invalidate any previous performance verification

testing. The Contractor shall deliver an OLI that permits the placement of the Thermal Infrared Sensor instrument consistent with the OLI-to-Spacecraft Interface Control Document.

4.2.13 Instrument Simulators Fabrication, Assembly, Test, and Delivery

The Contractor shall fabricate, assemble and test one OLI Interface Simulator and one OLI Simulator. The Contractor shall ensure that the OLI Interface Simulator and the OLI Simulator meet their respective requirements as defined in the OLI Requirements Document and the Observatory Interface Requirements Document.

The Contractor shall deliver the OLI Interface Simulator to the spacecraft contractor, and shall support verifying the interfaces between the spacecraft and OLI.

The Contractor shall deliver the OLI Simulator to the spacecraft contractor, and shall support its integration and test with the Spacecraft Simulator. The Contractor shall also deliver the de-integrated OLI Simulator from the spacecraft facility to the MOC, and support its re-integration and test with the Spacecraft Simulator. The Contractor shall support OLI Simulator testing and operation at the MOC in the OLI Simulator's role as part of the Observatory Simulator.

The Contractor shall increase Electrical Systems Engineering support through February 2011 to facilitate problem resolution and communication.

The Contractor shall maintain the OLI Simulator to the same software and hardware configuration as the flight OLI. The Contractor shall perform software and database updates to match the flight software and database modifications. The Contractor shall ensure the OLI Simulator software responses exhibit the same responses as the flight software.

4.2.14 Engineering Development Unit Fabrication, Assembly, and Test

The Contractor shall fabricate, assemble, test, and deliver the OLI Engineering Development Unit (EDU). The Contractor shall perform a thermal balance test on the EDU Focal Plane Assembly.

4.2.15 Data Processing Algorithms Code and Test

The Contractor shall code and test the data processing algorithms developed under CV-7, Data Processing Algorithms.

4.2.16 OLI Baseplate Mockup

The Contractor shall design, fabricate, and use a mockup of the OLI baseplate assembly and the thermal control subsystem for the purposes of reducing the risk of integration of the flight OLI Assembly.

4.3 Instrument Operations Support

4.3.1 Support to Mission Operations Element Development

The Contractor shall support the Government's development of the LDCM Mission Operations Element (MOE) by reviewing and providing comments on MOE documentation related to instrument command and telemetry.

4.3.2 Operational Procedures and Documentation

The Contractor shall develop and provide, at a minimum, the following CDRLs:

CDRL SE-14, Instrument Concept of Operations Document

CDRL OO-5, OLI Launch Commit Criteria

CDRL OO-7, OLI Launch and Early Orbit Procedures

CDRL OO-8, OLI On-Orbit Operations and Contingency Procedures

CDRL OO-10, OLI Constraints, Restrictions, and Warnings Document

The Contractor shall verify operations procedures on the instrument flight hardware prior to approval. The Contractor shall verify contingency procedures on the instrument flight hardware or instrument simulators prior to approval. The Contractor shall perform the software translation of these procedures from the test software/hardware environment to the operational software/hardware environment that will exist in the MOE. The Contractor shall review and provide inputs to Observatory-level procedures, including: Launch and Early Orbit, nominal, contingency, and satellite reconfiguration procedures.

4.3.3 Command and Telemetry Database Support

The Contractor shall supply the OLI Telemetry and Command Database, including stored and real-time commands for both nominal and non-nominal/contingency operations in accordance with CDRL OO-11. The Contractor shall ensure that the command and telemetry database is compliant with a Government-provided Data Format Control Document. The Contractor shall support the Government in conversion of instrument

command and telemetry databases for use in the Mission Operations Element. The Contractor shall provide the Instrument Telemetry and Command Handbook in accordance with CDRL OO-6. The Contractor shall place the telemetry and command database under formal configuration management.

4.3.4 Training Support

The Contractor shall provide training material to support Flight Operations Team training. The Contractor shall provide the OLI Training Materials in accordance with CDRL OO-9. The Contractor shall train up to twenty Flight Operations Team (FOT) participants and shall use as a basis, the Instrument Users Manual (OO-2). The Contractor shall prepare and provide all course materials, and conduct two two-day (16 hours) Flight Operations Team training classes at the MOC facility: one for the OLI instrument and one for the OLI Simulator. The Contractor shall also provide an additional identical set of training sessions for the FOT just prior to launch.

The Contractor shall recommend to the Government which activity(s) in the instrument integration and test flow would provide the best opportunity to introduce the Flight Operations Team to instrument operations through observation of I&T activities. The Contractor shall allow the FOT access to observe these activities on a non-interference basis.

4.4 Packaging, Handling, Storage, and Transportation

The Contractor shall provide the personnel, facilities, and hardware necessary to prepare and pack the OLI and its GSE for shipment, and shall be responsible for the transportation and shipment of the material to the designated spacecraft facility. The Contractor shall prepare, pack, and ship all OLI subsystems, systems, and the simulators between the places of manufacture, and integration and test, and storage and delivery in appropriate shipment containers. The Contractor shall prepare, pack, and ship all related calibration, mechanical, and electrical GSE required to support OLI subsystems, systems, and simulators during each phase of test, integration and launch preparation. The Contractor shall develop a Packaging, Handling, Storage, and Transportation (PHS&T) Plan and Procedures in accordance with CDRL IT-4 and shall ship the appropriate OLI systems, subsystems, and simulators and all related GSE in accordance with the Plan. The Contractor shall plan and support all activities necessary to safely ship the integrated LDCM Observatory and required OLI GSE, if any, to the launch base. The Contractor shall plan and support all activities necessary to safely ship the OLI Simulator and required GSE, if any, to the MOC from the spacecraft contractor's facility.

The Contractor shall, at the direction of the Government, store the OLI for a period of no more than one year prior to delivery to the spacecraft contractor's facility. If so directed, the Contractor shall implement the storage plans developed under CDRL IT-4.

4.5 Delivery, Checkout, and Acceptance

The Contractor shall unpack the flight hardware and GSE upon its arrival at the spacecraft contractor's facility, perform a visual inspection to detect physical damage, set up a bench test environment, and perform a post-delivery functional check out of OLI. The spacecraft contractor will provide facilities, security, storage, standard cleaning supplies, and standard test equipment (multimeter, probes, grounding, ionized air, etc.). The Contractor shall provide a bench check-out test report including comparison to the identical pre-ship test performed at the Contractor's facility. The Contractor shall compare the OLI post-shipment functional test results with the pre-shipment functional test results and provide comparative analyses and results.

Government conditional acceptance will occur after successful completion of post-delivery checkout. The Contractor shall deliver an Acceptance Data Package in accordance with CDRL SE-20. The Contractor shall be responsible for the OLI handling and operation from delivery until lifted "on-hook" by the spacecraft contractor for mechanical integration with the spacecraft. The spacecraft contractor will be responsible for maintaining and controlling a safe environment for all OLI hardware and personnel from the time of arrival at the spacecraft contractor's facility until delivered to the launch site, or ready to ship for return to the OLI Contractor, as directed by the Government.

4.6 Ground Support Equipment

4.6.1 Calibration Test Equipment

The Contractor shall define, design, build, provide, maintain, and document all equipment necessary to radiometrically, spectrally, and geometrically calibrate and characterize the OLI. The Contractor shall perform tests necessary to demonstrate that all Ground Support Equipment (GSE) is functioning properly and within specification.

4.6.2 Mechanical GSE

The Contractor shall define, design, build, provide, maintain, and document, as necessary, the mechanical GSE. Mechanical GSE consists of equipment and fixtures required to operate, test, handle, lift, perform optical alignment, and maintain the OLI, at the Contractor's facilities and at the spacecraft contractor's facilities. Mechanical GSE also includes equipment required to provide the appropriate thermal and vibration test environments at the Contractor's facilities as specified in the LDCM Environmental Verification Requirements. Mechanical GSE also includes equipment required to provide the required OLI thermal test environment inside the thermal vacuum chamber at the spacecraft contractor's facilities as specified in the LDCM Environmental Verification Requirements. The Contractor shall provide OLI instrument protective covers that protect fragile components from minor impact as well as contamination. The Contractor shall provide instrument drill templates to the Government to be used by the

spacecraft contractor to correctly place the instrument-mounting interface on the spacecraft. The Contractor shall maintain, calibrate, and certify mechanical GSE to Contractor standards.

4.6.3 Electrical GSE

The Contractor shall define, design, build, provide, maintain, and document, as necessary, the OLI electrical GSE throughout the duration of the contract. The electrical GSE consists of the System Test Equipment (STE) and software necessary to command, monitor, and test the OLI at the Contractor's facilities, at the observatory level, and at the launch facility to support all applicable testing (Comprehensive Performance Tests, Limited Performance Tests, environmental testing, end-to-end tests, etc.), as required. The Contractor shall maintain, calibrate, and certify electrical GSE to Contractor standards.

4.6.4 Shipping, Storage, and Purge Equipment

The Contractor shall provide environmentally controlled shipping and storage containers and necessary ancillary equipment, including shock recorders, for shipment of the OLI to the spacecraft contractor's facility.

The Contractor shall provide shipping and storage containers, and necessary ancillary equipment, as required, for shipment of the OLI Simulator and the OLI Interface Simulator to the spacecraft contractor's facility. The Contractor shall provide shipping and storage containers, and necessary ancillary equipment, as required, for shipment of the OLI Simulator to the MOC.

4.7 Spares

The Contractor shall define and implement a spares program appropriate to minimize delivery schedule impact created by failures, contamination, or by other plausible events or conditions for all flight and ground support equipment. The Contractor shall provide a Spare Parts Plan and List in accordance with CDRL SE-19. The Contractor shall qualify, test, and calibrate flight spares to the same level as the corresponding flight parts.

The Contractor shall process the spare telescope optics to a level sufficient to reduce the delay in completing the spare optics to no greater than 6 months should a problem develop with the primary set of optics.

5 Post-Delivery Support

5.1 *Observatory Integration and Test*

The Contractor shall provide all personnel, equipment, services, and materials necessary to test the OLI instrument at the observatory level of assembly, and to support observatory integration and testing. The majority of this support shall be provided on-site at the spacecraft contractor's facilities. Contractor-provided equipment shall include all GSE, intra-instrument test tees, interrupt boxes, and breakout boxes. For planning purposes, the Contractor shall assume that observatory launch readiness date is 10 months after instrument delivery.

5.1.1 Interface Testing

The Contractor shall provide all personnel and equipment necessary to plan, conduct, and verify readiness to interface the OLI with the spacecraft. The Contractor shall provide on-site personnel as required.

5.1.2 Observatory Integration

The Contractor shall plan, conduct, and provide on-site personnel necessary to integrate the OLI to the spacecraft. The Contractor shall perform the following, at a minimum:

- a. Perform safe-to-mate and signal characterization tests on all instruments and GSE prior to electrical mating.
- b. Assist and provide advice during OLI-related integration activities and testing conducted by the spacecraft contractor, including alignment and thermal blanket close-outs.
- c. Review and provide inputs to the OLI to spacecraft integration procedure.
- d. Provide the OLI spacecraft mounting hardware and electrical connectors.

5.1.3 Observatory Testing

The Contractor shall plan, analyze, and verify OLI performance at spacecraft ambient and environmental conditions in accordance with the contractor-generated System Performance Verification Plan. The Contractor shall provide on-site personnel on a 24/7 basis during spacecraft thermal vacuum testing. In addition, the Contractor shall provide personnel during other key spacecraft tests as defined by the Government. The Contractor shall provide personnel at the spacecraft contractor's facility to monitor the

OLI whenever the OLI is powered on. The OLI instrument will not be powered or operated on the spacecraft at any time without the Contractor I&T support staff present, concurring, and actively participating. The Contractor shall assume spacecraft thermal vacuum testing is eight weeks in duration. The Contractor shall provide on-site data analysis for all testing involving the instrument. The Contractor shall perform the following, at a minimum:

- a. Provide on-site support of all performance testing, including real-time monitoring and off-line data analysis, of the instrument after integration on the spacecraft, covering all shifts worked by the spacecraft contractor.
- b. Provide personnel to review procedures, provide expertise, witness testing, and interpret data before, during, and after OLI-related ambient and environmental testing conducted by the spacecraft contractor.
- c. Provide conversion of instrument GSE command and telemetry procedures for use in spacecraft GSE. Format is to be supplied by the spacecraft contractor.
- d. Support and conduct anomaly investigations involving the OLI and implement corrective actions.

The Contractor shall connect GSE to the OLI during Observatory I&T only on an as-needed exceptional basis for anomaly troubleshooting.

The contractor shall develop and implement the support equipment and the test algorithm(s) for an observatory-level OLI line of sight jitter test at the spacecraft contractor's facility. The contractor shall support test planning meetings and execution of the jitter test. The contractor shall perform real-time and post-test data analysis of OLI data and data from the contractor provided support equipment in order to provide a measurement of OLI observed jitter.

5.2 Mission Interface Testing and Rehearsal Support

5.2.1 Support to End-to-End Test(s)

The Contractor shall support Space Segment to Ground End-to-End testing. The Contractor shall demonstrate that the instrument science data can be processed to Level 0. The Contractor shall demonstrate that Level 1 data can be produced with the raw image data using simulated attitude and ephemeris data. The Contractor shall support and participate in every end-to-end test conducted prior to observatory shipment to the launch site. The Contractor shall:

- a. Participate with the Government in devising the test goals, requirements, and success criteria.
- b. Conduct reviews of the commands, telemetry, procedures, scripts, contingency plans, etc. to be used in the testing.

- c. Participate in a test readiness review approximately one week prior to the performance of each test that covers the test plan, procedures, scripts, and test support and coordination activities.
- d. Participate in test execution and generate data products, if required.
- e. Participate in post-test analysis of results.
- f. Resolve instrument anomalies and incorporate lessons learned for future tests.

5.2.2 Support to RF Compatibility Testing

The Contractor shall participate in planning for Radio Frequency (RF) Compatibility Tests between the Observatory and the NASA RF interface equipment (e.g., NASA Compatibility Test Van or other equipment). The OLI will be operated during RF Compatibility Testing to demonstrate compatibility and to provide a data stream.

5.2.3 Support to Launch Rehearsals and Exercises

The Contractor shall assist in planning and participate in a minimum of three launch rehearsals. The third Launch Rehearsal is a “full dress rehearsal” and includes participation by all LDCM Space, Ground, and Flight Operations segment personnel and resources required to conduct LEO activities. The launch rehearsals will demonstrate nominal execution of timelines as well as simulated anomaly/contingency response scenarios.

In addition, the Contractor shall participate in five training exercises with the Government provided FOT team to simulate typical day-in-the-life on-orbit Observatory operations. The exercises will simulate day-in-the-life scenarios that include exercise of nominal command and control operations, instrument tasking, state-of-health (SOH) procedures, and anomaly recovery operations.

For these exercises and launch rehearsals, the Contractor shall participate in:

- Devising the goals and resource requirements
- Reviews of planned activity with participants
- Executing the activity and collecting appropriate data
- Post-activity debriefs and lessons learned review with participants
- Generating a post activity report that documents the outcome of rehearsal activities.
- Resolving anomalies and incorporating lessons learned into future activities

5.2.4 Instrument Simulators Checkout, Acceptance, and Support

5.2.4.1 OLI Simulators

After shipment of the OLI Simulator and its GSE to the spacecraft contractor's facility, the Contractor shall perform a complete post shipment functional test of the Simulator and all GSE, after each shipment. The Contractor shall compare the Simulator post-shipment functional test results with the pre-shipment functional test results and provide comparative analyses and results. The Contractor shall provide expertise and on-site support for the integration of the OLI Simulator to the spacecraft simulator. The Contractor shall be responsible for the OLI Simulator operations, including after integration with the spacecraft simulator. The spacecraft contractor will be responsible for maintaining and controlling a safe environment for all OLI hardware and personnel while at the spacecraft facility. The Contractor shall be present, concurring and actively participating whenever the OLI Simulator is powered or operated by the spacecraft contractor.

When Observatory Simulator testing is complete, the Contractor shall support the de-integration of the OLI Simulator from the Spacecraft Simulator, as directed by the Government. After shipment of the OLI Simulator to the MOC, the Contractor shall perform a complete post shipment functional test of the OLI Simulators and all their GSE, after each shipment. The Contractor shall provide expertise and on-site support for the integration of the OLI Simulator to the spacecraft simulator. The Contractor shall be responsible for the OLI Simulator operations, including after integration with the spacecraft simulator. The Government will be responsible for maintaining and controlling a safe environment for all OLI hardware and personnel at the MOC. The Contractor shall be present, concurring and actively participating whenever the OLI Simulator is powered or operated by the spacecraft contractor, until accepted by the Government.

The Government will accept the OLI Simulator after it successfully passes its acceptance tests following delivery to the MOC. The Contractor shall prepare an Acceptance Data Package in accordance with CDRL SE-20.

5.2.4.2 OLI Interface Simulator

After shipment of the OLI Interface Simulator and its GSE to the spacecraft contractor's facility, the Contractor shall perform a complete post shipment functional test of the OLI Interface Simulator and all GSE, after each shipment. The Contractor shall compare the OLI Interface Simulator post-shipment functional test results with the pre-shipment functional test results and provide comparative analyses and results. The Contractor shall be responsible for the OLI Interface Simulator operation until successful integration with the spacecraft.

The Contractor shall provide expertise and on-site support for the integration of the OLI Interface Simulator to the spacecraft. The Contractor shall be present, concurring and actively participating whenever the OLI Interface Simulator is powered or operated by the spacecraft contractor, until accepted by the Government.

The Government will accept the OLI Interface Simulator after it is successfully tested with the spacecraft. The Contractor shall prepare an Acceptance Data Package in accordance with CDRL SE-20.

5.3 Launch and Early Orbit Support

The Contractor shall conduct post-shipment instrument checkout at the payload processing facility in accordance with the Integration and Test Plan, as appropriate.

The Government will maintain and control a safe environment for all OLI hardware and personnel from the time of arrival at the payload processing facility through launch.

The Contractor shall participate in launch preparations and provide launch site and Mission Operations Center (MOC) launch support, providing all necessary personnel, services, and materials.

The Contractor shall participate in launch, Observatory deployment, instrument activation including deployments, and early on-orbit activation activities performed from the Government-provided MOC.

5.4 Commissioning, including On-Orbit Check-out

Commissioning is the series of events after spacecraft and instrument activation that includes instrument checkout and performance verification prior the start of nominal LDCM operations. The Contractor shall perform whatever actions required to place the OLI in an operational state prior to the end of commissioning. At the end of the commissioning phase, the Government will determine if the OLI is ready for nominal operations.

5.4.1 Instrument Checkout

The Contractor shall perform post-launch verification and test of the OLI.

The Contractor shall perform instrument checkout at the Government-provided MOC, providing all necessary personnel, services, and materials.

A Government-provided Flight Operations Team, trained by the Contractor, will execute all instrument commands as expressly authorized by the Contractor.

The Contractor shall complete OLI checkout within 90 days after launch, providing all necessary personnel, services, and materials.

The Government will provide to the Contractor a list of World Reference System–2 (WRS-2) scenes that will be used by the Government for independent validation of image quality. Included in this list will be scenes to be imaged off-nadir. The FOT will acquire data for each of these scenes within 90 days after launch.

From these Government-provided scenes, and using Contractor-generated algorithms, the Contractor shall provide data products that demonstrate compliance with specifications. The Government will furnish ground control points and digital elevation models for these scenes. The Government will provide to the Contractor the Level 0 data for all acquired scenes.

The Contractor shall assist the Government in reconciling any differences in data product results between results derived from Contractor-provided algorithms and results derived from Government-derived operational algorithms.

The Contractor shall, at a minimum:

- a. Provide an OLI On-Orbit Commissioning Plan in accordance with CDRL OO-1.
- b. Determine the duration of the instrument outgassing period and monitor outgassing effectiveness during commissioning phase.
- c. Provide OLI On-Orbit Test and Calibration/Validation Procedures in accordance with CDRL OO-12.
- d. Review and analyze OLI post-launch test data and provide On-Orbit Test Reports in accordance with CDRL OO-3.
- e. Conduct OLI post-launch pre-Initial Operational Capability (IOC) testing in accordance with the System Performance Verification Plan (SPVP).
- f. Conduct tests in accordance with the Special Calibration Test Requirements Document.
- g. Participate in Observatory activity planning, including, but not limited to, schedule planning and Observatory maneuver requirements related to completion of Special Calibration Test Requirements (SCTR) activities.
- h. Calibrate the OLI and determine the OLI calibration parameters.
- i. Investigate and resolve on-orbit anomalies that affect OLI specification-related performance parameters and/or anomalies that threaten OLI health and safety.
- j. Provide an On-orbit Anomaly Resolution Support Plan in accordance with CDRL OO-4.

The Government, with Contractor support, will conduct a full 16-day “operational” imaging cycle prior to Acceptance.

5.4.2 Acceptance

The Government will accept the OLI at the end of the commissioning phase, and after the successful completion of the On-Orbit Acceptance Review.

In a non-nominal launch or commissioning situation, the Contractor shall provide engineering and operations support until Government acceptance or disposition. For planning purposes, the Contractor shall assume this engineering and operations support will be 3 months in duration and, if required, will be performed in lieu of the nominal commissioning phase activities.

6 Engineering Support

The Contractor shall provide engineering support as defined below after final on-orbit acceptance of OLI.

6.1 *Nominal Operations*

The Contractor shall provide the following services after Government acceptance through the period of performance of the contract:

1. Management, systems engineering, and administrative support to engineering support activities to include the following. For estimating purposes assume a level of effort of approximately 10 hours per week for the first 2 years and 5 hours per week for the remaining 3 years.
 - a. Communicate the project status on a monthly basis in accordance with CDRL O&M-1.
 - b. Provide financial data on a monthly basis in accordance CDRL O&M-2.
 - c. Participate in a joint LDCM Configuration Control Board with the Government. For estimating purposes assume one teleconference meeting per month of one-half day duration starting at the end of the commissioning phase.
 - d. Provide a Project Management Plan in accordance with O&M-3 due 30 days following contract transition to the USGS.
2. Maintain* the SDVF as required in support of Section 6.2 Task Support.

NOTE: *Maintain in this context is defined as:

- a. Preserving configuration of prescribed system.
- b. Performing routine activities required to ensure the system is in working order when needed.
- c. Investigating issues and providing an assessment to the Government of recommended actions to achieve continued operability of non-COTS hardware.

6.2 *Task Support*

The Contractor shall perform tasks relating to the continued on-orbit support of LDCM, as authorized by the Government and in accordance with the Contract. Each task will be initiated by written direction from the Government contracting officer. The Government will coordinate with the Contractor to define each task in detail, and establish manpower ceilings, performance schedules, and deliverables.

These Government-initiated tasks may include but are not limited to the following:

1. Support post-Commissioning operations as required. This support can include: supplying technical expertise to perform analyses, to review data, or to review changes to documentation.

2. Investigate on-orbit anomalies that affect specification-related performance parameters and/or anomalies that threaten OLI health and safety and provide recommendations for resolution.
 - a) The Contractor shall acknowledge notification of the anomaly and provide an initial action plan within 24 hours of notification by the Government. The Government will follow up with written direction and coordinate the task details as soon as possible.
 - i. An action plan describes the activities intended to support the anomaly investigation.
3. Maintain flight software and provide updates to flight software to provide capabilities requested by the Government.
 - a) Provide technical documentation, installation procedures, on-orbit validation procedures and back-out procedures
4. Maintain the OLI Simulator (OS) in the MOC in accordance with Flight Software updates.
5. Provide calibration and validation consultation support to the Government on an as-needed basis.
6. Participate as necessary in the Decommissioning Review prior to decommissioning of the observatory at end-of-life.

7 Optional Extended Support

If the Government exercises the optional one-year extensions of on-orbit support in accordance with the Contract, the Contractor shall perform the following during the option period.

7.1 Nominal Operations

The Contractor shall provide the following services after Government acceptance through the period of performance of the contract:

1. Management, systems engineering, and administrative support to engineering support activities to include the following. For estimating purposes assume a level of effort of 5 hours per.
 - a) Communicate the project status on a monthly basis in accordance with CDRL O&M-1.
 - b) Provide financial data on a monthly basis in accordance CDRL O&M-2.
 - c) Participate in a joint LDCM Configuration Control Board with the Government. For estimating purposes assume one teleconference meeting per month of one-half day duration starting at the end of the commissioning phase.
2. Maintain* the SDVF as required in support of Section 6.2 Task Support.

NOTE: *Maintain in this context is defined as:

- a) Preserving configuration of prescribed system.
- b) Performing routine activities required to ensure the system is in working order when needed.
- c) Investigating issues and providing an assessment to the Government of recommended actions to achieve continued operability of non-COTS hardware.

7.2 Task Support

The Contractor shall perform tasks relating to the continued on-orbit support of LDCM, as authorized by the Government and in accordance with the Contract. Each task will be initiated by written direction from the Government contracting officer. The Government will coordinate with the Contractor to define each task in detail, and establish manpower ceilings, performance schedules, and deliverables.

These Government-initiated tasks may include but are not limited to the following:

1. Support post-Commissioning operations as required. This support can include: supplying technical expertise to perform analyses, to review data, or to review changes to documentation.

2. Investigate on-orbit anomalies that affect specification-related performance parameters and/or anomalies that threaten OLI health and safety and provide recommendations for resolution.
 - a) The Contractor shall acknowledge notification of the anomaly and provide an initial action plan within 24 hours of notification by the Government. The Government will follow up with written direction and coordinate the task details as soon as possible.
 - i. An action plan describes the activities intended to support the anomaly investigation.
3. Maintain flight software and provide updates to flight software to provide capabilities requested by the Government.
 - a) Provide technical documentation, installation procedures, on-orbit validation procedures and back-out procedures
4. Maintain the OLI Simulator (OS) in the MOC in accordance with Flight Software updates.
5. Provide calibration and validation consultation support to the Government on an as-needed basis.
6. Participate as necessary in the Decommissioning Review prior to decommissioning of the observatory at end-of-life.